Chapter 7. Drinking Water Treatment and Distribution

Drinking-water treatment includes physical, biological, and chemical processes to make water suitable for potable use. Distribution includes the storage, pumping, and pipe systems to protect and deliver the water to customers. Even after preventing pollution and matching water quality to water use (see preventing pollution and matching water quality to water use strategies), drinking water supplies will generally still require some of level of treatment to achieve a potable level of quality, which will then need to be maintained in a distribution system. Widespread treatment of drinking water, especially disinfection and fluoridation, was one of the great public health advancements of the 20th century.

Drinking Water Treatment and Distribution in California

The State of California has a role in ensuring the safety of the public water supply and the health of Californians who use it. State Department of Health Services regulations require all surface waters in California be filtered and disinfected, except for a small number that meet DHS's "filtration avoidance" criteria, like San Francisco's Hetch Hetchy water supply.[1] Basic surface water treatment consists of pretreatment (primarily sedimentation), filtration through sand and gravel followed by disinfection with chlorine. Many water suppliers use more advanced treatment such as granular activated carbon (GAC) for filtration and ozone and chloramination, a combination of chlorine and ammonia, for disinfection. Together, filtration and disinfection are the key parts of the traditional "multiple-barrier" approach to treating drinking water. This is consistent with an integrated, "source-to-tap" approach to water quality, which can be expanded upstream to include watersheds, and downstream, to include distribution systems.

In Southern California, the Los Angeles Department of Water and Power has disinfected Owens Valley water with ozone for the past 20 years. The Metropolitan Water District is upgrading to ozone disinfection at its five treatment plants, which use either Delta water exclusively, or a blend of Colorado River and Delta water. UV radiation is a promising advanced disinfection technology, but has yet to be implemented in a large-scale domestic water treatment plant in California. The integration of multiple disinfectants also shows promise in optimizing protection from microbiological contaminants in drinking water. Some smaller water treatment plants use membrane filtration, which produces relatively high quality water. The waterworks industry is exploring the feasibility of point-of-entry (POE) and point-of-use (POU) devices, which would treat only that water used for domestic purposes, and which could provide quicker and more cost-effective water quality improvements. Water systems that rely on groundwater disinfect well water only with chlorine, unless a specific contaminant is found.

Distribution system water quality is emerging as an important issue in the waterworks community, especially given recent heightened awareness of water supply security. Historically, treated water storage and associated distribution systems were designed to meet fire suppression flow requirements rather than water quality. Water in distribution systems can be contaminated by cross-connections with non-potable water, such as recycled water, open treated water distribution reservoirs, and water main repair and replacement. Lead, the by-products of corrosion, and regrowth of microorganisms can also contaminate water. Ironically, the implementation of ozone for disinfection, while effective in killing microbes, reducing objectionable tastes and odors, and generally forming fewer disinfection byproducts, can create

[1] Please refer to Volume 1, Chapter 2, for the legal and regulatory framework for drinking water treatment and distribution.

conditions that can encourage the growth of microorganisms in water distribution systems. Aging water systems -- some well over 100 years old -- in general are not being replaced or rehabilitated within their useful lives. Small, rural water systems, that is those serving fewer than 3,300 connections, face unique treatment and distribution challenges, because they lack the technical and financial ability to address water contamination. Such systems are often the most frequent violators of drinking water standards. And they often must cope with some of the most difficult water quality problems, such as arsenic and more traditional contaminants such as nitrate and coliform bacteria.

Potential Benefits

Improved water quality can directly improve the health of Californians, thereby improving the state's standard of living and reducing the burden and costs on the state's healthcare system. Many water contaminants potentially cause cancer, nervous system and organ damage, developmental impairments, and dysfunction of the reproductive and endocrine systems; others can cause short-term gastrointestinal illnesses, resulting in lost work and school days. If poor water quality causes a need for medical treatment by many uninsured Californians, the costs will be borne by state health programs, such as MediCal, which directly impacts the State budget. In addition, many consumers who choose to purchase relatively expensive bottled water or home treatment units, could save more of their personal budgets if they instead used safe tap water.

The U.S. Environmental Protection Agency has proposed new regulations to reduce both the gastrointestinal and carcinogenic disease risks of drinking water. The agency estimates that the Long Term 2 Enhanced Surface Water Treatment Rule will prevent more than 1 million cases of cryptosporidiosis, a gastrointestinal ailment, and up to 140 premature deaths annually, providing $1.4 billion in benefits. EPA also estimates that the Stage 2 Disinfection Byproducts Rule will prevent up to 182 cases of bladder cancer per year, providing nearly $1 billion in benefits. USEPA also estimates that the combined costs of these two proposed regulations are less than $24 per year for most households.

Potential Costs

Advanced water treatment itself is about 1 percent of a customer's overall water bill. For example, the 40 million gallon-per-day North Bay Regional Water Treatment Plant, which serves Fairfield and Vacaville, treats a blend of Lake Berryessa and Delta water with GAC filtration and ozone. The operations and maintenance expenses of this plant costs $0.04 per 1,000 gallons, on a total metered charge of $3 per 1,000 gallons. Also, the Metropolitan Water District of Southern California estimates that its capital upgrade to ozonation will cost about $83,000 per acre-foot per day of capacity, with operations and maintenance costs of $9-$12 per acre-foot (equal to $0.03 to $0.04 per 1,000 gallons). Nonetheless, despite the relatively low costs, economies of scale negatively affect small water systems that have a smaller rate base to spread both capital and O&M expenses.

As for infrastructure, the American Society of Civil Engineers (ASCE) recently gave a grade of "D" to drinking water infrastructure, in its 2003 Progress Report for America's Infrastructure. EPA estimated in October 2002 that over the next 20 years, the nation would be short $535 billion for water and wastewater infrastructure. The drinking water estimate alone was $265 billion. EPA estimates California's drinking water infrastructure needs about $1 billion annually over the next 20 years.[2] EPA also predicted that per

[2] Adjusted to January 2004 dollars, EPA's estimate for California is $17 billion to $21 billion.

household costs to small water systems will be four times that of customers of large water systems -- those serving more than 50,000 persons.

Major Issues

Access to Safe Drinking Water

Safe drinking water is fundamental to public health. DWR's recent report *Californians Without Safe Water*, found that more than 81,000 California households may rely upon an unsafe source of water. In lieu of a connection to a public water system, many of these households may be obtaining their drinking water from shallow wells, springs, or hauled-water supplies that are vulnerable to contamination. Moreover, many other households and schools, often in rural or low-income areas, are connected to small water systems that are less scrutinized by regulatory agencies. These small systems usually have limited funds and staffing to pursue improvements in drinking water quality, including the preparation of grant applications for funding assistance. Even for those households that are connected to a public water system, DHS reports that in 2001, more than 40,000 people got their water from public water systems that had repeated violations of the coliform bacteria drinking water standard, and that more than 700,000 people were served water in violation of surface water filtration and disinfection regulations. In addition, nearly 1 million Californians got water in 2001 from public water systems that had a "significant sanitary defect involving sewage."

Emerging Contaminants

New contaminants are often discovered and then regulated because of increased pollution, improved analytical abilities, and better understanding of health effects. In addition, the health effects of many known contaminants are re-evaluated--and re-regulated--in light of new information. For many emerging contaminants (for example, from personal care products and pharmaceuticals), there may not yet be treatment technologies available to remove them from drinking water. For such contaminants, only pollution prevention, or matching water quality to water use, will adequately address water quality. In fact, emerging contaminants may be created by treatment itself, for instance, when water utilities implement new methods or processes for disinfecting water. For some contaminants, treatment options, such as membranes, may be available, but they are relatively expensive.

Risk, Demographic Changes

There are increasing numbers and proportions of immunocompromised individuals, as well as children and elderly, who are more susceptible than the general population, to the risks of waterborne disease and exposure to contaminants. At the same time, water agencies are responding to regulatory signals that require control of disinfection byproducts in treated surface water. Depending upon the treatment scheme employed, measures to reduce the probable long-term risks of cancer can be at odds with efforts to protect the public from known short-term risks from microorganisms.

Contaminant Interactions and Cumulative Effects

There is growing concern about the interactions and cumulative effects on human health of multiple contaminants in drinking water. Such effects are not addressed by current drinking water standards, which only regulate contaminants on an individual basis. Moreover, some contaminants, such as disinfection byproducts, present risks simultaneously through multiple exposure routes (e.g. ingestion, inhalation, or the skin). The CALFED Drinking Water Quality Program is attempting to address this concern via its "Equivalent Level of Public Health Protection" strategy, which looks comprehensively at the total

concentration of contaminants in drinking water, and integrates pollution prevention, alternative water sources, facility re-operation, and advanced treatment to reduce contaminants.

Recreation

The State Department of Parks and Recreation forecasts an increasing demand for recreation on reservoirs, including drinking water reservoirs, such as Lake Perris in Southern California. An increase in reservoir contamination, especially microbiological from swimmers, water skiers or others whose bodies come in contact with the water, can correspondingly increase the need for treatment and degrade the quality of tap water produced from these lakes.

Public Distrust

Public opinion surveys consistently suggest that Californians, across all socio-economic groups distrust their tap water, often because of tap water taste, odor, or appearance. They choose instead to rely on home treatment devices and bottled water. Quite simply, improvements in water quality may not lead to improvements in public health if the public is not drinking the water. While some amount of bottled water use is related to convenience or lifestyle choices, the poor perception of tap water is a factor as well. However, the public may not have access to complete information about the relative safety of bottled and tap waters, and may be misplacing their trust in sales pitches for bottled water and home treatment devices.

Affordability

Even though water treatment is a relatively small portion of a customer's water bill, increased costs are a concern for many people. As costs increase, the relative burden on the household budgets of poor families will increase at rates greater than that of the general population. Moreover, the waterworks industry generally lacks lifeline rates for poor customers relative to other utilities, such as gas, electricity, and telephone. For those economically disadvantaged consumers who choose to purchase bottled water, money spent on that commodity may be better spent on other life necessities.

Recommendations to Improve Drinking Water Treatment and Distribution

1. All Californians should have access to safe drinking water. Thus, the State should assist in funding drinking water and wastewater infrastructure needs in areas--including on tribal lands--without piped domestic water and therefore not covered by the State and federal Safe Drinking Water Acts. Further, the State should implement the recommendations of DWR's 2003 report, *Californians Without Safe Water*.
2. The State, local water agencies, and non-profit organizations should better educate the public about the actual and perceived risks of tap water, bottled water, and water produced by home treatment units. State and local water agencies should specifically improve outreach to and communication with vulnerable populations that may indeed be at a higher actual level of risk of waterborne disease or other health effects from drinking water contaminants. Doctors and other healthcare professionals, in whom the public may place their trust, should be involved in this effort.
3. Communities should have useful access to, knowledge of, and engagement in, drinking-water quality monitoring and assessment. In addition, decision-making at all government levels should be transparent and involve affected communities, tribes, and general purpose local governments. Examples of vehicles for such access, knowledge, and engagement include citizen water quality

monitoring programs, and water quality community advisory committees, at the local water system level.

4. The State should consider increasing the set-aside funding for capacity building within the Drinking Water State Revolving Fund to the maximum allowed by EPA for these purposes. Systems that serve large proportions or numbers of vulnerable populations, such as schools, should receive funding priority. The State should increase its formal partnerships with non-governmental organizations that are experienced in assisting small water systems in grant and loan applications, in order to improve community access to information and funding, address the most pressing public health risks, and ensure an equitable distribution of grant and loan funds.
5. The State should implement guidelines for the design and operation of distribution systems to maintain system water quality. As a part of these guidelines, the State should ensure that public water systems are prepared for natural and man-made disasters, and are able to reliably maintain or quickly restore water quality in the aftermath of such disasters.
6. Water utilities must prevent possible cross-contamination of potable water from dual-plumbing of potable and recycled water distribution systems and other non-potable sources.
7. In response to continuing, legitimate concern from citizens, the State should monitor and resolve the potential health impacts of indirect potable reuse of recycled water.
8. The State Water Project and local agencies should only permit recreation on reservoirs that do not endanger the public health of those who drink the water from those reservoirs.
9. The State should coordinate its funding sources (e.g., the Drinking Water and Clean Water State Revolving Funds) in order to better address projects with multiple benefits – such as drinking water supplies threatened by contamination from septic systems. State water quality funding sources for small water systems should be closely coordinated with federal water quality monies, including funds available from the U.S. Department of Agriculture.

Information Sources

- *Bay-Delta Water Quality Evaluation*, California Urban Water Agencies, June 1998
- *Drinking Water into the 21st Century; Safe Drinking Water Plan for California, A Report to the Legislature*, California Department of Health Services, January 1993
- *Californians Without Safe Water, California 2002,* Department of Water Resources, 2002
- 2000 US Census
- USEPA Drinking Water Program, www.epa.gov/safewater/
- USEPA Needs Survey, www.epa.gov/OGWDW/needs.html
- Congressional Budget Office, www.cbo.gov/execsum.cfm?index=3983&from=1&file=ExecSum.htm
- Water Infrastructure Network, www.win-water.org/
- City of Fairfield
- Metropolitan Water District
- California Department of Parks and Recreation
- ASCE 2003 Progress Report for America's Infrastructure